

3.23 CLUTTER REJECTION DOPPLER FILTERS

As described in the previous section, clutter rejection for pulse Doppler radars comes from two sources in ESAMS. One source is the Doppler filter attenuation that is centered at the target Doppler frequency. Whenever the difference in Doppler frequencies between the target and the clutter (at zero Hz) is greater than the bandwidth of the filter (specified by the RDRD variable, FULBW2), attenuation will occur. The second source of attenuation arises if the user enables the MTI flag (MTION in the PROGC). For pulse Doppler radars, the MTI flag has nothing to do with MTI, but rather, adds an idealized notch filter with a bandwidth of XNOCHW (RDRD variable) which is centered at zero Hz. The signal attenuation is equal to the value of the RDRD input, FULIF2, whenever the signal is within the filter bandwidth, otherwise no attenuation is applied.

For Doppler filtering, the type of Doppler filter used depends on the RDRD variable CHEBYL. If CHEBYL is equal to zero, a truncated Gaussian filter shape of the form:

$$k = 2^{-f^2/2}$$

is used, where f is the difference between the signal frequency and the filter center frequency, normalized to the filter half-power frequency. The half-power frequency is taken to be one-half of the input filter bandwidth (FBWIF2). If CHEBYL is greater than zero, the filter response is given by:

$$k = \frac{1}{\sqrt{1 + [eT(L, f)]^2}}$$

where $T(L, f)$ is the Chebyshev polynomial of order L , and e is the so-called ripple parameter (defaulted to 0.01).

3.23.1 Objectives and Procedures

The objective of this analysis was to examine the Doppler filter response as a function of Doppler frequency for several different Chebyshev orders. The Doppler filter attenuation is computed in subroutine DOPFIL by means of a call to subroutine ATNAMP which subsequently calls the function CHEBY for the value of the Chebyshev polynomial. The response functions were computed by developing a simple driver for subroutine ATNAMP that looped over the Doppler frequencies of interest.

3.23.2 Results

The Doppler filter response for a 1000 Hz filter with Chebyshev polynomials of order 1, 5, and 9 are plotted in Figure 3.23-1. For a Chebyshev polynomial of order 1, the filter response is simply the Doppler offset normalized by the half-power frequency. This leads to a significantly lower attenuation than the higher-order polynomials outside of the (500 Hz) filter half-power frequency. For the higher-order polynomials there are some differences in the ripple characteristics, but more significant is the filter rolloff outside of the filter passband. As illustrated in Figure 3.23-2, the higher the order, the faster the rolloff and the higher the attenuation with increasing frequency offset. Real filters typically have a floor of maximum attenuation. A limit of maximum attenuation given by the RDRD variable FULIF2 is modeled for the truncated Gaussian filter shape (CHEBYL=0), but no limit is currently imposed with the Chebyshev filters.

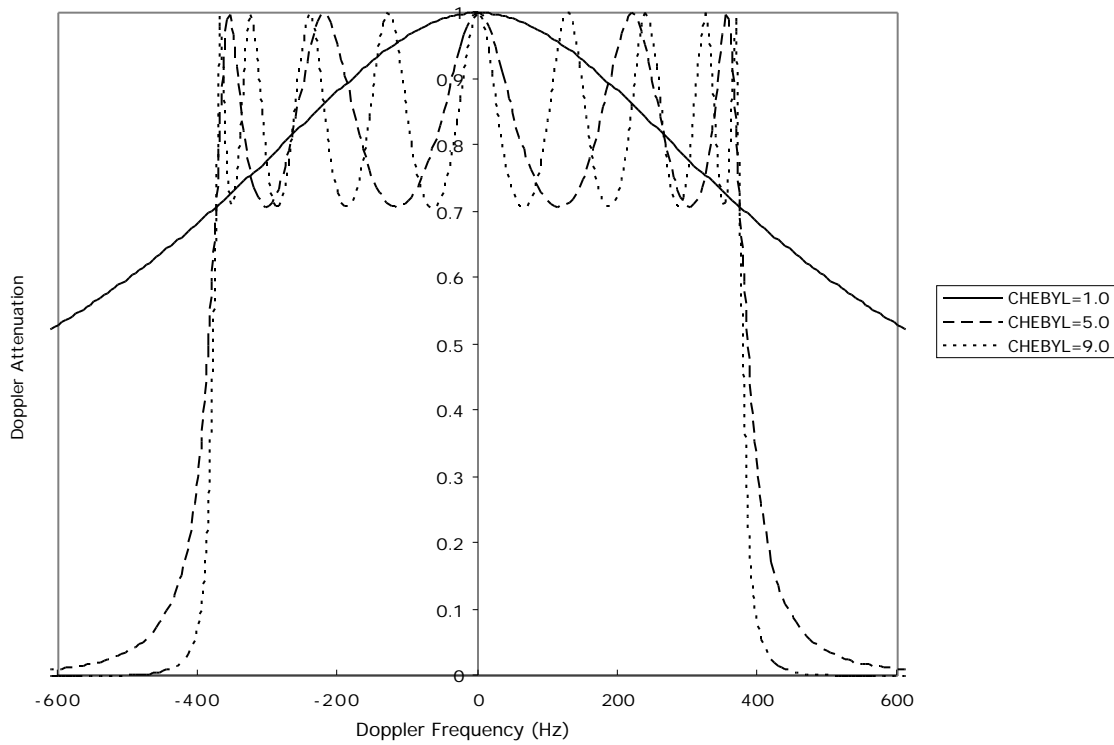


FIGURE 3.23-1. Doppler Filter Response as a Function of Frequency for Different Chebyshev Orders.

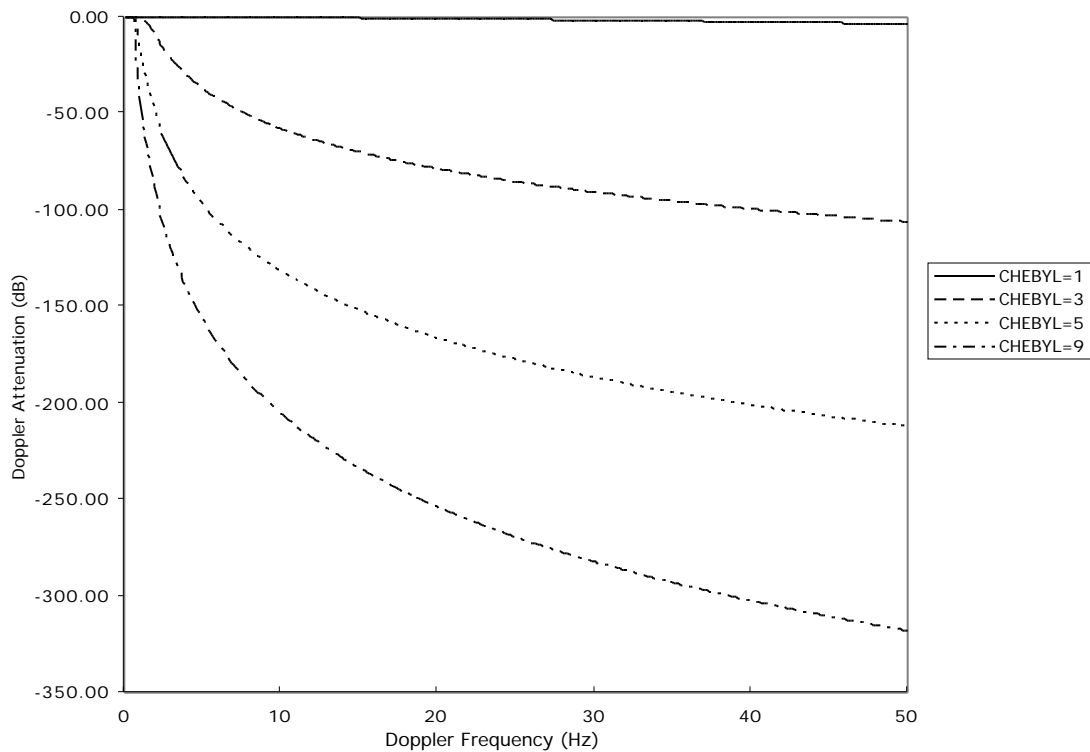


FIGURE 3.23-2. Doppler Filter Rolloff (in dBs) as a Function of Frequency and Chebyshev Polynomial Order.

3.23.3 Conclusions

The only potential problem with the Doppler filtering of clutter noted is that the Chebyshev filter has an unbounded rolloff with increasing Doppler frequency. Real filters are limited to some maximum attenuation, and the ESAMS attenuation should be bounded by the RDRD variable, FULIF2, in subroutine ATNAMP. (An MDR has been submitted.)

